

IDENTIFICATION OF TREE VEGETATION IN PASIR PUTIH COASTAL FOREST TOURISM AREA, ACEH BESAR REGENCY

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ABSTRACT

Tree vegetation plays a crucial role in maintaining ecosystem balance, particularly in preventing erosion and sediment loss in Pasir Putih Beach Tourism Area. This study aims to identify and analyze the density of tree vegetation in Pasir Putih coastal forest located in Aceh Besar Regency. The research employed the Point Centered Quarter (PCQ) method, dividing the study site into three observation stations. At each station, a 100meter transect line was established with four sampling points per station, where the nearest tree to each point was measured and recorded. The environmental parameters observed included temperature, soil pH, soil moisture, and air humidity. The findings revealed a total of 11 tree species belonging to 11 families, consisting of 41 individual trees across all stations. The most dominant species in Pasir Putih Beach Tourism Area was *Avicennia marina* (grey mangrove), with 20 individual trees. Based on data analysis, the tree density at transect one was 0.0420, at transect two was 0.0371, at transect three was 0.0625, and the overall tree density across all transects was 0.0455.

Keyword: Identification, Pasir putih beach, Tree vegetation

ABSTRAK

Vegetasi pada pohon berperan penting dalam menjaga keseimbangan ekosistem yakni berperan untuk mencegah terjadinya erosi serta pengikisan di Kawasan Wisata Pantai Pasir putih. Tujuan penelitian ini adalah untuk mengidentifikasi dan mengetahui kepadatan vegetasi pohon yang terdapat di kawasan Pasir Putih Kabupaten Aceh Besar. Penelitian ini menggunakan metode Point Centered Quarter (PCQ) dengan menetapkan lokasi penelitian menjadi 3 stasiun. Pada tiap stasiun ditarik line transek 100meter dengan 4 titik per stasiun dengan ukuran pohon yang terdekat dengan titik jarak. Parameter lingkungan yang diukur dalam penelitian ini adalah suhu, pH tanah, kelembaban tanah, dan kelembaban udara. Hasil penelitian ditemukan jumlah pohon pada seluruh stasiun pengamatan terdapat 12 spesies yang tergolong kedalam 11 famili dan 41 total individu. Pohon yang mendominasi di kawasan wisata pantai pasir putih adalah bakau api-api sebanyak 20 individu. Berdasarkan hasil analisis data yang dilakukan kepadatan pohon transek satu adalah 0,0420776, kepadatan pohon transek dua adalah 0,037161, kepadatan pohon transek tiga adalah 0,0625 dan kepadatan pohon semua transek adalah 0,0455111.

Kata Kunci: Identifikasi, Pantai pasir putih, Vegetasi pohon

Introduction

Coastal forests play a vital role as habitats for a wide variety of plant and animal species that are unique to coastal environments. Any disturbance to this ecosystem can affect its biodiversity, potentially disrupting ecological balance and weakening its environmental functions. Conversely, forest ecosystems with high biodiversity levels tend to exhibit greater stability. Lowland tropical forests also make substantial contributions to human life by providing numerous ecosystem services. These services include mitigating tsunami impacts, preventing coastal abrasion, and protecting terrestrial ecosystems from strong winds and storms. Moreover, such forests help control erosion, serve as habitats for various species of flora and fauna, and provide breeding grounds for wildlife. In addition, tropical forests play a role in reducing global warming and serve as sources of industrial raw materials, such as cosmetics, biodiesel, and pharmaceuticals, as well as renewable bioenergy (Tuheteru et al., 2012).

Urban areas, as centers of human activity, have very high population densities. The rapid growth of the economic sector and urban population has led to the conversion of green open spaces for other purposes (Nisa et al., 2022). In this context, the existence of urban forests becomes increasingly important for enhancing environmental quality (Atmajayani, 2020). Urban forests also play a key role in regulating urban microclimates by reducing air temperature, absorbing solar radiation, and moderating surface water flow, thus maintaining ecological balance within cities (Handayani et al., 2021).

If coastal development does not adhere to principles that prioritize environmental protection and sustainability, it can result in degradation of coastal ecosystems and disrupt ecological balance. One of the crucial parameters for assessing environmental stability is vegetation diversity, which plays a significant role in supporting sustainable ecosystem management (De Boeck et al., 2018).

Vegetation ecosystems in coastal areas possess great potential for development as ecotourism destinations, which can in turn enhance the welfare of local communities (Sanchez-Prieto et al., 2021). To ensure their long-term benefits, sustainable conservation and management efforts are essential. Vegetation refers to the overall composition of plant species growing in an area, not merely a collection of coexisting plants, but an interdependent community interacting within its environment. Various environmental factors such as climate, soil characteristics, and the presence of herbivores have a significant influence on the level of plant diversity within an ecosystem (Dong et al., 2019).

Coastal vegetation provides essential ecological services that support environmental balance. Plant communities that grow in the transitional zones between marine and terrestrial environments serve as food sources, shelters, and habitats for diverse flora and fauna, contributing substantially to biodiversity conservation (Matatula et al., 2019). Moreover, coastal plant communities have become increasingly important subjects of research due to their strategic roles in natural disaster mitigation, climate change adaptation, and rural development. However, despite their ecological significance, coastal vegetation is among the most vulnerable ecosystems globally. The reduction or loss of vegetation along coastlines increases coastal vulnerability to negative impacts such as storm damage and

tsunamis, which may harm both local communities and surrounding ecosystems (Melati, 2020).

Coastal vegetation plays a crucial role in maintaining environmental stability and protecting nearby settlements. One of its primary functions is to act as a natural barrier against strong winds, thereby reducing potential damage to buildings and human activities. Additionally, coastal vegetation minimizes the rate of coastal abrasion caused by ocean waves. Beyond its physical protection role, it also provides significant ecological benefits by absorbing and reducing atmospheric carbon emissions, contributing to climate change mitigation. Furthermore, it helps prevent seawater intrusion into terrestrial areas, which can degrade soil fertility and reduce freshwater availability for local communities (Sadono, 2020).

Research on tree vegetation has been previously conducted by Rudin (2020), who investigated the potential of tree vegetation diversity in supporting water conservation in Kolobon Village, Rote Ndao, East Nusa Tenggara Province. The study identified 27 tree species belonging to 16 families, with *Moraceae* and *Fabaceae* being the most dominant, and the tree diversity index categorized as high. Another study by Maulani et al. (2022) examined tree vegetation in Brayeun River area, Leupung District, Aceh Besar Regency, identifying 22 species from 17 families with a total of 94 individuals. The dominant species in that area was durian (*Durio zibethinus L.*), although the tree diversity index was classified as low. In contrast, a study by Annisa et al. (2016) on coastal vegetation at Pasir Jambak Tourism Area, Padang City, recorded five families, five species, and 36 individuals.

Based on the literature and ecological importance outlined above, this study aims to identify tree vegetation and determine tree density in Pasir Putih Coastal Forest Tourism Area, Aceh Besar Regency.

Methods

This research was conducted from February to March 2025 in Pasir Putih Coastal Forest Area, located in Aceh Besar Regency, Indonesia.

The equipment used in this study included a digital camera, soil tester, hygrometer, lux meter, knife, raffia string, GPS (Global Positioning System), and observation sheets. The materials used consisted of writing tools, data tables, and raffia strings for marking.

The study employed a purposive sampling technique, where tree characteristics were used as selection criteria to facilitate species identification. The Point Centered Quarter (PCQ) method was used as the main data collection approach. PCQ is a distance-based method that does not require quadrat plots; instead, the distance between a sampling point and the nearest plant in each of the four quadrants is measured.

Data collection was carried out at three sampling stations, each spaced approximately 50 meters apart. Every station contained a 100 meter transect line with four sampling points per station. Each sampling point was divided into four quadrants, each representing the nearest tree to that point. For each identified tree, measurements included tree height, diameter at breast height (DBH), leaf photographs, and species identification to determine its taxonomy.

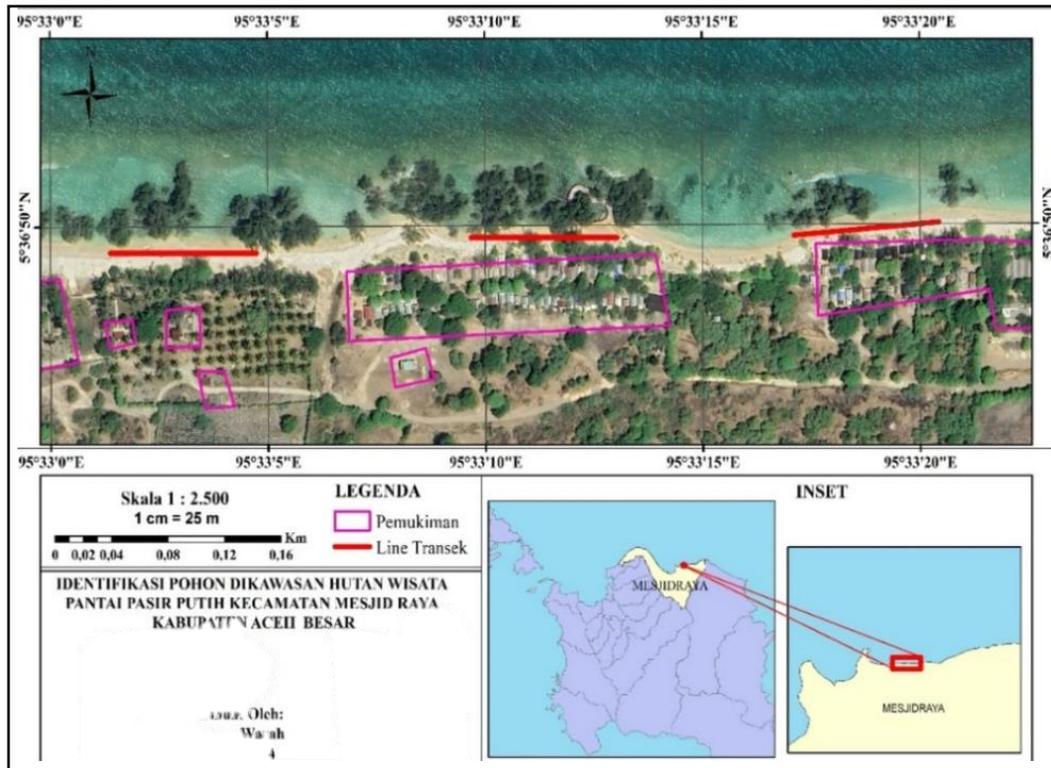


Figure 1. Map of the Research Location in Pasir Putih Coastal Area, Aceh Besar Regency

The primary parameters observed were tree species, tree height, and tree density. Supporting environmental parameters measured included air temperature, humidity, soil pH, and soil moisture. These parameters were recorded to obtain accurate and comprehensive data for assessing the environmental conditions that influence tree growth and distribution.

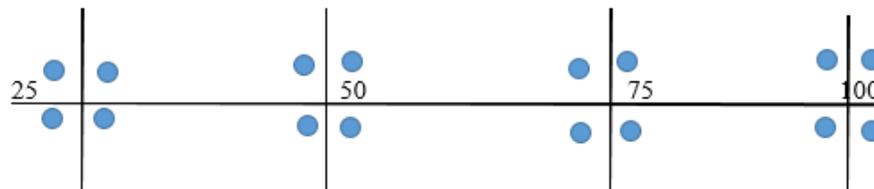


Figure 2. Transect illustration

a were analyzed qualitatively. The scientific and local names of each species identified were recorded and tabulated to facilitate interpretation. Each identified species was described based on its morphological characteristics. Tree density was calculated to determine the relative contribution and dominance of each species within the ecosystem. The findings were presented in the form of tables and descriptive explanations to provide a clear overview of vegetation structure in the study area.

$$\text{Species Density} = \frac{\text{Number of Individuals of Each Species}}{\text{Total Sampling Area (m}^2\text{)}}$$

Results and Discussion

Tree Species Found in Pasir Putih Coastal Forest Tourism Area

Table 1. Types of Trees Identified Across All Observation Stations

No	Local Name	Scientific Name	Family	Number of Individuals
1	Grey Mangrove	<i>Avicennia marina</i>	Acanthaceae	20
2	Sea Hibiscus	<i>Hibiscus tiliaceus</i>	Malvaceae	5
3	Coastal She-Oak	<i>Casuarina equisetifolia</i>	Casuarinaceae	2
4	Screw Pine	<i>Pandanus odorifer</i>	Pandanaceae	1
5	Neem Tree	<i>Azadirachta indica</i>	Meliaceae	3
6	Indian Almond	<i>Terminalia catappa</i> L.	Combretaceae	3
7	Coconut Palm	<i>Cocos nucifera</i> L.	Arecaceae	2
8	Black Lannea	<i>Lannea nigriflora</i>	Anacardiaceae	1
9	Beach Gardenia	<i>Guettarda speciosa</i>	Rubiaceae	1
10	Indian Jujube	<i>Ziziphus mauritiana</i>	Rhamnaceae	2
11	Indian Beech	<i>Pongamia pinnata</i> L.	Fabaceae	1
Total				41

Source: Research Data (2025)

The results of the study conducted in 2025 identified a total of 12 tree species belonging to 11 families, with 41 individual trees distributed across all observation stations in Pasir Putih Coastal Forest Area, Aceh Besar Regency. Among these, *Avicennia marina* (grey mangrove) from the Verbenaceae family was the dominant species, accounting for 20 individuals. The next most abundant species was *Hibiscus tiliaceus* (sea hibiscus) from the Malvaceae family, with five individuals. Other species such as *Casuarina equisetifolia*, *Cocos nucifera* L., and *Ziziphus mauritiana* were also recorded but in smaller numbers. Species with only one individual included *Pandanus odorifer*, *Lannea nigriflora*, *Guettarda speciosa*, and *Pongamia pinnata* L.

Complete information on the identified tree species including local names, scientific names, families, and the number of individuals recorded at each observation station is presented in Table 1.

Table 2. Distribution of Trees Across Observation Stations in Pasir Putih Coastal Forest Area

Transect	Point	Quadrant	Local Name	Scientific Name	Distance from Point (m)	Tree Height (m)	DBH (cm)
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I	1	1	Grey Mangrove	<i>Avicennia marina</i>	3	8	45
		2	Indian Almond	<i>Terminalia catappa</i> L.	5	10	120
		3	Neem Tree	<i>Azadirachta indica</i>	5	9	90
		4	Grey Mangrove	<i>Avicennia marina</i>	6	15	203
	2	1	Grey Mangrove	<i>Avicennia marina</i>	5	14	198
		2	Indian Beech	<i>Pongamia pinnata</i> L.	6	8	84
		3	Cemara	<i>Casuarina equisetifolia</i>	7	14	170
		4	Grey Mangrove	<i>Avicennia marina</i>	5	15	200
	3	1	Grey Mangrove	<i>Avicennia marina</i>	4	9	40
		2	Sea Hibiscus	<i>Thespesia populnea</i>	4	9	74
		3	Indian Beech	<i>Pongamia pinnata</i> L.	3	8	69
		4	Grey Mangrove	<i>Avicennia marina</i>	5	18	200
	4	1	Grey Mangrove	<i>Avicennia marina</i>	4	16	200
		2	Cemara	<i>Casuarina equisetifolia</i>	5	13	95
		3	Sea Hibiscus	<i>Thespesia populnea</i>	6	7	67
		4	Grey Mangrove	<i>Avicennia marina</i>	5	12	120
II	1	1	Grey Mangrove	<i>Avicennia marina</i>	3	14	189
		2	Indian Jujube	<i>Ziziphus mauritiana</i>	5	7	198
		3	Screw Pine	<i>Pandanus odorifer</i>	7	7	91
		4	Grey Mangrove	<i>Avicennia marina</i>	4	12	132
	2	1	Grey Mangrove	<i>Avicennia marina</i>	5	15	154
		2	Neem Tree	<i>Azadirachta indica</i>	7	10	60
		3	Sea Hibiscus	<i>Thespesia populnea</i>	8	8	75
		4	Grey Mangrove	<i>Avicennia marina</i>	4	14	147
	3	1	Grey Mangrove	<i>Avicennia marina</i>	5	13	132
		2	Beach Gardenia	<i>Guettarda speciosa</i>	4	8	60
		3	Neem Tree	<i>Azadirachta indica</i>	6	8	50
		4	Grey Mangrove	<i>Avicennia marina</i>	4	11	121
	4	1	Grey Mangrove	<i>Avicennia marina</i>	3	11	117
		2	Black Lannea	<i>Lannea nigritana</i>	4	9	110
		3	Coconut Palm	<i>Cocos nucifera</i> L.	10	14	100
		4	Grey Mangrove	<i>Avicennia marina</i>	4	15	156
III	1	1	Grey Mangrove	<i>Avicennia marina</i>	3	13	141
		2	Indian	<i>Terminalia catappa</i>	5	15	96

		Almond				
	3	Sea Hibiscus	<i>Thespesia populnea</i>	7	12	73
	4	Grey Mangrove	<i>Avicennia marina</i>	4	12	131
2	1	(-)				
	2	Coconut Palm	<i>Cocos nucifera L.</i>	8	15	79
	3	Neem Tree	<i>Azadirachta indica</i>	6	10	86
	4	(-)				
3	1	Grey Mangrove	<i>Avicennia marina</i>	5	12	127
	2	Indian Jujube	<i>Ziziphus mauritiana</i>	4	7	83
	3	Beach Gardenia	<i>Guettarda speciosa</i>	6	8	80
	4	Grey Mangrove	<i>Avicennia marina</i>	4	12	131
4	1	(-)				
	2	Indian Almond	<i>Terminalia catappa</i>	5	11	81
	3	Sea Hibiscus	<i>Thespesia populnea</i>	7	10	86
	4	(-)				
Total				225	498	5061

Basic Calculations

Average distance between trees (m)	4,6875
Squared mean distance (md ²)	21,972656
Tree density/m ² =1/md ²	0,0455111
Tree density/ha = 1/md ² x 10,000	455,11111

These findings suggest that the area supports moderate species diversity but with a strong dominance by *Avicennia marina*, which is ecologically adapted to saline and sandy environments typical of coastal zones. In addition, several other tree species were also identified, such as *Terminalia catappa L.* (indian almond), *Azadirachta indica* (neem tree), *Casuarina equisetifolia* (coastal she-oak), *Thespesia populnea* (sea hibiscus), *Pandanus odorifer* (screw pine), *Guettarda speciosa* (beach gardenia), *Lannea nigritana* (black lannea), serta *Cocos nucifera L.* (coconut palm). The basic calculations of the PCQ analysis showed an average tree-to-point distance of 4.69 m, with a mean squared distance of 21.97. The tree density was calculated at 0.0455 trees per m², equivalent to 455 trees per hectare. This density indicates a relatively high level of vegetation cover, particularly in areas where *Avicennia marina* populations are concentrated, playing a critical role in stabilizing the coastal ecosystem.

Morphological and Ecological Descriptions of Identified Tree Species

1. Grey Mangrove (*Avicennia marina*)

This species grows upright with numerous spreading branches. Its pneumatophores (aerial roots) grow vertically, slender, and in large numbers. The leaves are opposite, petiolate, and obovate in shape with blunt tips and flat bases. The trunk secretes a bitter latex, while the fruit is a box-shaped capsule containing a single seed capable of viviparous germination.



Figure 3. Grey Mangrove (*Avicennia marina*)

2. Sea Hibiscus (*Hibiscus tiliaceus*)

Hibiscus tiliaceus is a widely distributed coastal tree that can grow up to 15 meters tall. Its bark is smooth, grayish-brown, and mottled. The leaves are simple, alternately arranged, and heart-shaped with pointed tips. The bell-shaped yellow flowers bloom in the afternoon, gradually turning orange or darker toward evening.



Figure 4. Sea Hibiscus (*Hibiscus tiliaceus*)

3. Coastal She-Oak (*Casuarina equisetifolia*)

This species is characterized by its evergreen foliage that remains green throughout the year, even under varying weather conditions. The small, jointed branchlets resemble pine needles, and its fruits are small, cone-shaped structures. The leaves are minute, pointed, and scale-like, giving the tree its distinctive appearance.



Figure 5. Coastal She-Oak (*Casuarina equisetifolia*)

4. Screw Pine (*Pandanus odorifer*)

Species of the *Pandanus* genus are mostly found in tropical coastal and riverine regions, although absent in the Americas. They are widely used in traditional crafts, including woven mats and food covers. *Pandanus odorifer* grows upright, either as a tree or shrub, reaching 5–15 meters in height. Its stem is branched, occasionally thorny, and supported by prop roots. The long, waxy leaves ranging from 5 to 6 meters in length and 7–10 centimeters in width are triangular at the tip, with spiny margins and midribs (Ramandey, 2021).



Figure 6. Screw Pine (*Pandanus odorifer*)

5. Neem Tree (*Azadirachta indica*)

This species is highly tolerant of dry and nutrient-poor soils. It can reach heights between 8 and 50 meters. The leaves are elongated, alternate, and serrated along the edges, measuring 3–8 cm long and 3–4 cm wide. The oval fruits have a thick, fleshy pulp, while the bark is rough, hard, and brownish near the base. The sharp leaf tips and serrated margins are characteristic features of this plant (Rufah, 2020).



Figure 7. Neem Tree (*Azadirachta indica*)

6. Indian Almond (*Terminalia catappa* L.)

Terminalia catappa L. is easily recognized by its pagoda-like branching structure and large, broadly ovate leaves. The fruit is flattened and oval-shaped. This coastal species thrives on sandy and rocky beaches, showing high tolerance to salinity, sea spray, and strong winds. It grows best under full sunlight in humid tropical regions (Soegiarto, 1992).



Figure 8. Indian Almond (*Terminalia catappa* L.)

7. Coconut Palm (*Cocos nucifera* L.)

Cocos nucifera L. is a perennial monocot belonging to the family Arecaceae. It is among the most economically and culturally significant tropical plants, as nearly every part of the coconut palm is utilized by humans. The leaves are used for traditional roofing and crafts, the fruit for food and oil production, the trunk for construction materials, and the roots for medicinal purposes (Fauzana et al., 2021).



Figure 9. Coconut Palm (*Cocos nucifera* L.)

8. Black Lannea (*Lannea nigritana*)

The leaves and bark of *Lannea nigritana* are widely used in traditional medicine. The leaves are used to treat digestive disorders, coughs, and respiratory problems, while the bark is known for its effectiveness in addressing diseases such as dysentery and diabetes. Its bioactive compounds are believed to help regulate blood sugar levels and support digestive health, making it an important herbal resource.



Figure 10. Black Lannea (*Lannea nigritana*)

9. Beach Gardenia (*Guettarda speciosa*)

This species commonly grows as a shrub in coastal rocky habitats. The dark green leaves have prominent yellow veins. It produces fragrant white flowers throughout the year, although each bloom lasts only briefly. The spherical fruits are hard and buoyant, facilitating natural seed dispersal via seawater. Its wide distribution extends along Indian and Pacific Ocean coastlines.



Figure 11. Beach Gardenia (*Guettarda speciosa*)

10. Indian Jujube (*Ziziphus mauritiana*)

Ziziphus mauritiana is a hardy shrub that adapts well to both arid and saline soils. It typically grows up to 1.5 meters tall, with thorny, irregularly arranged branches. The leaves remain green year-round, indicating evergreen characteristics. The plant exhibits complete structural organs such as flowers, fruits, stems, roots, and leaves that function synergistically in its growth and reproduction.



Figure 12. Indian Jujube (*Ziziphus mauritiana*)

11. Indian Beech (*Pongamia pinnata* L.)

Pongamia pinnata L. is a deciduous tree ranging from 15 to 25 meters in height and up to 80 cm in diameter. Its branching pattern is irregular, and each twig bears 5 to 9 compound leaflets. The species contributes to nitrogen fixation, making it ecologically valuable in maintaining soil fertility and supporting coastal ecosystem resilience.



Figure 13. Indian Beech (*Pongamia pinnata* L.)

Environmental Conditions of the Study Area

Table 3. Environmental Conditions in Pasir Putih Coastal Forest Tourism Area

No.	Research Station	Soil Moisture %	Soil pH	Air Humidity %	Temperature °C
1.	Station 1	35	5	50	30,2
2.	Station 2	30	4,5	53	29,8
3.	Station 3	32	4,8	49	31,1

Source: Research Data (2025)

Environmental conditions in Pasir Putih Coastal Forest Tourism Area were analyzed based on several parameters, including soil moisture, soil pH, air humidity, and temperature. Measurements were conducted at three observation stations. At

Station 1, soil moisture was 35%, soil pH 5.0, air humidity 50%, and temperature 30.2°C. At Station 2, soil moisture was 30%, soil pH 4.5, air humidity 53%, and temperature 29.8°C. At Station 3, soil moisture was 32%, soil pH 4.8, air humidity 49%, and temperature 31.1°C. These data show noticeable variation across stations, influenced by microclimatic and edaphic factors such as geographical location, soil type, sunlight exposure, and wind intensity. Such variations play a role in determining species composition and tree density patterns in Pasir Putih coastal ecosystem.

Discussion

Based on the results of the study, it was found that Pasir Putih Coastal Forest Tourism Area contains 12 tree species belonging to 11 families, with a total of 41 individual trees recorded across all observation stations. Among the various species identified, *Avicennia marina* (grey mangrove) was the most dominant, with 20 individuals recorded. The presence of this species indicates that the ecosystem in this area provides environmental conditions suitable for the growth and development of *Avicennia marina*, which is likely influenced by factors such as soil type, water availability, and other ecological parameters.

Observations of tree distribution across the three research stations revealed that *Avicennia marina* (grey mangrove) and *Hibiscus tiliaceus* (sea hibiscus) were the most dominant species. *Avicennia marina* accounted for 20 individuals, while *Hibiscus tiliaceus* comprised 5 individuals. Both species exhibited a wide distribution, occurring at all three observation stations. Specifically, *Avicennia marina* and *Hibiscus tiliaceus* were evenly distributed throughout the study area, demonstrating their ecological adaptability to coastal environments. In addition, several other tree species were identified in smaller numbers, ranging from 1 to 3 individuals per species. These included *Azadirachta indica* (neem tree), *Lannea nigriflora* (Black Lannea), *Pandanus odorifer* (screw pine), *Terminalia catappa* L. (indian almond), *Cocos nucifera* L. (coconut palm), *Ziziphus mauritiana* (indian jujube), *Guettarda speciosa* (beach gardenia), *Pongamia pinnata* L. (indian beech), and *Casuarina equisetifolia* (coastal she-oak). The relatively small number of individuals from these species compared to *Avicennia marina* and *Hibiscus tiliaceus* indicates lower dominance and a less dense presence within the study area.

Environmental conditions at Pasir Putih Coastal Forest Tourism Area were analyzed based on several parameters, including soil moisture, soil pH, air humidity, and temperature. Measurements were taken at three research stations: Stations 1, 2, and 3. At Station 1, soil moisture was recorded at 35%, with a soil pH of 5.0, air humidity of 50%, and temperature of 30.2°C. At Station 2, soil moisture was slightly lower at 30%, with a pH of 4.5, indicating higher soil acidity. Air humidity reached 53%, while temperature was 29.8°C. At Station 3, soil moisture was 32%, soil pH 4.8, air humidity 49%, and temperature the highest among all stations at 31.1°C. These data show variations in environmental conditions across stations, influenced by several factors such as geographical position, soil characteristics, sunlight exposure, and wind intensity. Tree density values calculated for transect 1: 0.0421 trees/m², transect 2: 0.0372 trees/m², transect 3: 0.0625 trees/m², and average tree density (all transects): 0.0455 trees/m².

Conclusion

In Pasir Putih Coastal Forest Tourism Area, a total of 11 tree species belonging to 11 families were identified, with 41 individual trees recorded across all observation stations. Environmental factors such as soil moisture, air humidity, soil pH, and temperature were found to significantly influence the occurrence and distribution of tree vegetation in the area. The analysis showed an average tree-to-point distance of 4.68 m, with a mean squared distance of 21.97. The average tree density across all transects was 0.0455 trees/m², equivalent to approximately 455 trees per hectare.

This study contributes baseline information for future research on coastal vegetation identification and density analysis. Furthermore, the findings are expected to support the development of more diverse and innovative approaches in vegetation research, particularly for sustainable coastal ecosystem management.

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References

Quotes from the books

Tuheteru F, Mahfudz D. 2012. *Ekologi, Manfaat & Rehabilitasi, Hutan Pantai Indonesia*. Balai Penelitian Kehutanan Manado. Manado.

Quotes from the articles

Annisa Novianti Ssamin, Chairul et al (2016) Analisis Vegetasi Tumbuhan Pantai pada Kawasan Wisata Pasir Jambak kota Padang. *Biocелеbes*. Vol.10. Hal 32-42.

De Boeck HJ, Bloor JMG, Kreyling J, Ransijn JCG, Nijs I, Jentsch A, Zeiter M. (2018) Patterns and drivers of biodiversity-stability relationships under climate extremes. *J Ecol* 106:890-902.

Dong, S., Sha, W., Su, X. Zhang, Y., LI S., Gao, X., Liu, S., Shi, J., Liu, Q., Hao, Y. The impacts of geographic, soil and climatic factors on plant diversity, biomass and their relationships of the alpine dry ecosystems: Cases from the Aerjin Mountain Nature Reserve. *China. Ecol. Eng.* 2019. 127, 170-177.

Fauzana, N., Pertwi, A.A., dan Ilmiah, N. 2021. Etnobotani Kelapa (*Cocos nucifera* L. L) di Desa Sungai Kupang Kecamatan Kandungan Kabupaten Hulu Sungai Selatan. *Journal Science And Local Wisdom*. Vol 1(1):45-56.

- Handayani, Indarjani, Jannah. M., A'yun. Q., Ahmad. Y. 2021. Analisa vegetasi dan potensi dua hutan kota (study kasus hutan kota pondok kelapa dan hutan kota kampong dukuh Jakarta timur), Kocenin serial konferensi, 1.2.8.1.
- Matatula, J., Poedjirahajoe, E., Pudyatmoko, S., and Sadono, R. 2019. The Spatial Spread Of Mangrove Forest Environmental Condition at Kupang Seashore. *Jurnal of Natural Resources and Environmental Management* 9 (2) : 467-482.
- Maulani, P. I., Hidayat, M & Amin, N. 2022. Struktur Vegetasi Riparian di Kawasan Sungai Brayeun Kecamatan Leupung Aceh Besar. *Prosiding Seminar Nasional. Jurnal ar-raniry Volume 10, No 1.*
- Nisa, A., Muslih, A.M., dan Sugianto. 2022. Identifikasi Sebaran Pohon di Hutan Kota BNI Banda Aceh. *Jurnal Ilmiah Mahasiswa Pertanian. Vol.7 No. 2. 748-753.*
- Sanchez Prieto MC, Luna Gonzales A, Espinoza tenorio A, Gonzales Ocampi HA. 2021. Planning ecotourism in coastal protected areas, projecting temporal management scenarios. *Sustainability. 13:1-13.*